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The Food of Cod on Faroese Grounds

By BENNET B. RAE

Marine Laboratory, Aberdeen
July, 1967

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The Food of Cod on Faroese Grounds

INTRODUCTION

The food of cod was studied on cruises by Scottish research vessels from 1921 to 1965. The results have already been published of an investigation based primarily on an examination of the stomach contents of cod of 21 cm and over caught, mainly by trawl, in the North Sea and off the west coast of Scotland (Rae, 1967). From 1949 to 1962 similar observations, employing the same techniques, were made on cod of the same size during Scottish research vessel cruises to Faroese grounds. The results obtained are summarised in this paper.

The examination of the stomachs and their contents was carried out during the routine observations on the catches immediately after each trawl haul. Particular attention was paid to the identification of the various groups of animals and genera represented in the food, but in the circumstances little effort was made to determine the individual species preyed upon. A list of genera and species identified is given in the appendix.

No attempt was made to measure the volumes of food in the stomachs or the volumes of the various food types but the numbers of stomachs with and without food were recorded, and on a number of cruises estimations were made of the fullness of the individual stomachs. The fish were considered according to their size in two groups, 21-50 cm and 51 cm and over. Small cod of less than 21 cm were not included in the survey.

The sampling of the cod in each locality at Faroe is shown in Figure 1 and by months in Table I.

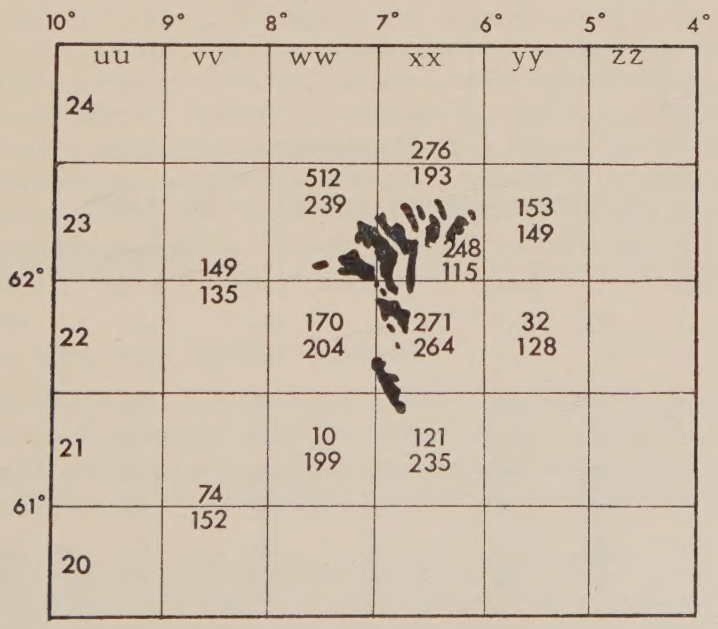

Figure 1. Sampling of cod stomachs at Faroe, 1949–1962;
Upper no.=21–50 cm Lower no.=51 cm and over

TABLE I

FEEDING OF COD AT FAROE, 1949–1962
NUMBERS EXAMINED AND NUMBERS WITH EMPTY STOMACHS (ALSO EXPRESSED AS PERCENTAGES) THROUGHOUT THE YEAR

	21–50 cm			51 cm and over			Totals		
Month	No. Exam.	No. Empty	%	No. Exam.	No. Empty	%	No. Exam.	No. Empty	%
January	129	15	11·6	93	14	15·1	222	29	13·1
February	3	—	—	3	1	—	6	1	—
March	4	—	—	1	—	—	5	—	—
April	24	2	8·3	43	7	16·3	67	9	13·4
May	70	10	14·3	109	27	24·8	179	37	20·7
June	442	49	11·1	138	27	19·6	580	76	13·1
July	359	44	12·3	568	46	8·1	927	90	9·7
August	4	—	—	—	—	—	4	—	—
September	521	96	18·4	321	53	16·5	842	149	17·7
October	497	100	20·1	578	139	24·1	1075	239	22·2
November/December	140	25	17·9	167	26	15·6	307	51	16·6
Totals	2193	341	15·5	2021	340	16·8	4214	681	16·2

TABLE II

INTENSITY OF FEEDING OF COD ON FAROESE GROUNDS

			Fullness of Stomachs						
Year	Month		Empty	Traces	¼ full	½ full	¾ full	Full	Total
1958	June	No.	31	24	104	95	78	43	375
		%	8	6	28	25	21	11	
1959	May	No.	31	24	56	13	8	11	143
		%	22	17	39	9	5	8	
1960	September	No.	110	24	222	174	64	75	669
		%	16	4	33	26	10	11	
1960	October	No.	104	22	81	62	25	18	312
		%	33	7	26	20	8	6	

INTENSITY OF FEEDING THROUGHOUT THE YEAR

Table I also gives the numbers and percentages of cod with empty stomachs in each month. Sampling at Faroe was less regular throughout the year than in Scottish waters; nevertheless, on the assumption that the proportion of empty stomachs is indicative of the intensity of feeding, the results show that feeding varies in intensity from month to month. On the evidence available feeding seems to be fairly heavy in January and April but to decline sharply in May. Thereafter, a rapid recovery occurs in June, to reach a maximum feeding intensity in July. By September feeding is again declining and reaches a minimum intensity in October, after which there is again a slight recovery. Despite the rather inadequate sampling at certain times of the year, the cycle of feeding intensity at Faroe, as demonstrated by Table I, is of particular interest in that it follows a similar cycle of feeding in the North Sea and other Scottish waters. At Faroe, however, the various phases of the cycle are each about a month later than in Scottish waters. The cycles in the two regions may be summarised thus:—

	Scotland	*Faroe*
Intensive feeding	January—February	January—?—April
Spring decline	March—April	May
Maximum intensity	June	July
Autumn decline	September	October
Moderate feeding	October—December	November—December

Evidence of seasonal differences in the feeding of cod in Scottish waters was also found in the degrees of fullness of the stomachs. Similar observations on the amount of food contained in the stomachs of cod at Faroe were recorded on four cruises. These are listed in Table II along with the numbers and percentages of the various categories from 'empty' to 'full'. Empty stomachs were least numerous in June and most numerous in October, while full stomachs were rather more prevalent in June and September than in May and October. The most significant feature of Table II, however, is that cod with empty or less than half-full stomachs constituted 42% of the total examined in June compared with 78% in May, 53% in September and 66% in October. On the other hand cod with stomachs half-full or more than half-full of food constituted 57% of those examined in June, compared with 22% in May, 47% in September and 34% in October. Although not wholly conclusive these results seem to indicate that the feeding of cod at Faroe is heavier in June than in any of the other months in which stomachs were examined for the amount of food they contained. Table II also indicates that feeding is less intensive in May and October than in September. Certain features of this study seem, therefore, to support the evidence of Table I. From an examination of both tables it may be concluded that the heaviest feeding of cod at Faroe takes place in June and July, while feeding is at its lightest in October and May.

Discussion of Seasonal Decline in Feeding Intensity

It has been suggested (Rae, 1967) that the decline in the feeding of cod in Scottish waters during March and April may be linked with the spawning of the fish in these months. It has also been shown, however, that the feeding of the smaller fish, 21-50 cm, most of which are immature or adolescent, also declines in the Scottish area in the same months, which suggests that feeding at that time may also be affected by some factor other than spawning.

According to Tåning (1943) the chief spawning period for cod at Faroe is from early in March to the beginning of May. This is slightly later than in Scottish waters so that the rather later spring decline in the feeding of cod at Faroe still seems to suggest a link with spawning. The decline in the feeding of adult cod at Faroe (24·8% with empty stomachs) in May, is comparable with the 24·6% empty in Scottish waters in March.

The spring decline in the feeding of the smaller fish (21-50 cm) at Faroe (14·3% with empty stomachs in May), however, is not so marked as it is in the Scottish area. It seems possible that the decline in the intensity of feeding which both precedes and follows the intensive summer feeding of cod may yet be explained by some behavioural feature of the fish. It is to be hoped that light may be thrown on this phenomenon by the current investigations of fish behaviour.

THE FOOD OF COD ON A REGIONAL OR LOCAL BASIS

The results of this investigation have been considered on a regional or local basis in order to trace changes in the food of the cod from one area to another.

Sando and Sydero Banks (Table III)

Sampling on these banks was less frequent than on most of the other Faroese grounds and most of the fish taken were of the larger size. Fish predominated in the food of both size-groups with gadoids, mainly *Gadus esmarkii*, and, to a less degree, sand eels the predominant types.

Fuglo Grounds (Table IV)

Both size-groups were equally represented on these grounds. Fish were the principal food of both groups with gadoids and sand eels again providing the bulk of the food. Of the seven decapod types preyed upon, *Pandalus* outnumbered all the others in the diet of the smaller cod. Molluscs, polychaetes and ophiuroids were also represented in the food in small numbers.

Northern Grounds (Table V)

These grounds were sampled from April to December over a period of ten years. All sizes of cod were represented, with the smaller size-group occurring rather more frequently than the larger. In this area the food of the smaller fish consisted mainly of decapod crustaceans, with fish taking a position of secondary importance. In the food of the larger fish the relative importance of these two food types was reversed. On these grounds molluscs and, to a less extent, polychaetes appeared more frequently in the stomachs. Of the individual genera recognised, *Pandalus* was the outstanding decapod food of both size-groups, although eupagurids and *Hyas* were also well represented. Among the fish types sand eels slightly outnumbered the gadoids.

Bordo and Svino Grounds (Table VI)

On these grounds, where sampling included hauls close to the three miles' limit, the smaller cod were more plentiful than the larger fish. Decapod crustaceans were clearly the chief food of the smaller cod, to which fish types were of much less importance. Decapods and fish proved to be of equal importance in the diet of the larger cod. Molluscs, mainly in the form of the gasteropod *Buccinum*, were found to be eaten fairly frequently by fish of all sizes.

Of the decapods eaten, *Pandalus* was again the outstanding type in the food of both size-groups, while *Galathea* was also eaten frequently by the smaller fish. Eupagurids, *Hyas* and, to a less extent, *Portunus* and *Crangon* were also prominent in the stomach contents. Of the fish types, haddock and sand eels greatly outnumbered all the other types, which also included various species of no direct economic importance.

TABLE III

FOOD OF COD ON SANDO AND SYDERO BANKS (YY22bc)

Years	1959–1962				
Months	V, VII, IX, X				
Depth range in metres	157–188				
Length range in cm	32–50	51–93			
No. stomachs examined	32	128			
No. empty	10	25			
No. with recognisable food	22	103			
Percentage feeding on:—					
CRUSTACEA	14	15	PISCES	91	89
Eupaguridae	—	1	*Ammodytes* spp.	9	3
Hyas	—	1	*Gadus* spp.	14	13
Lithodes	—	2	*G. aeglefinus*	—	4
Galathea	—	2	*G. esmarkii*	5	15
Munida	5	6	*G. poutassou*	—	5
Crangon	5	—	*Hippoglossoides*	—	2
Pandalus	—	1	*Sebastes*	—	1
MOLLUSCA	—	5			
Cephalopoda	—	4			

TABLE IV

FOOD OF COD ON FUGLO GROUNDS (YY23ad)

Years	1952–1962				
Months	V–VII, IX, X				
Depth range in metres	91–176				
Length range in cm	24–50	51–89			
No. stomachs examined	153	149			
No. empty	36	44			
No. with recognisable food	117	105			
Percentage feeding on:—					
CRUSTACEA	36	24	PISCES	78	85
Eupaguridae	4	6	*Ammodytes* spp.	17	23
Portunus	1	2	*Gadus* spp.	16	8
Hyas	4	8	*G. aeglefinus*	7	13
Galathea	3	2	*G. esmarkii*	4	8
Munida	1	1	*G. poutassou*	2	3
Crangon	3	—	Flatfish	1	2
Pandalus	19	3	*Clupea harengus*	—	1
MOLLUSCA	4	7	*Gobius*	1	—
Gasteropoda	3	3	*Sebastes*	—	1
Lamellibranchiata	—	1	POLYCHAETA	—	4
Cephalopoda	1	2	*Aphrodite*	—	1
Octopod	1	—	OPHIUROIDEA	—	1

TABLE V

FOOD OF COD ON NORTHERN FAROESE GROUNDS (XX23ab, XX24d)

Years	1952–1962	
Months	IV, VII, IX, X, XII	
Depth range in metres	80–128	
Length range in cm	25–50	51–92
No. stomachs examined	276	193
No. empty	50	29
No. with recognisable food	226	164
Percentage feeding on:—		
CRUSTACEA	67	40
Decapoda ? sp.	+	—
Eupaguridae	12	10
Portunus	2	4
Hyas	5	10
Lithodes	—	1
Galathea	7	2
Munida	3	1
Crangon	3	1
Pandalus	21	12
Hippolyte	1	—
Isopoda	—	1
Euphausiacea	—	1
MOLLUSCA	13	11
Gasteropoda	7	7
Buccinum	—	2
Lamellibranchiata	4	1
Pecten	+	—
Chlamys	+	—
Mytilus	+	—
Cephalopoda	2	2
Eledone	—	1
PISCES	38	76
Ammodytes spp.	12	30
Gadus spp.	10	16
G. aeglefinus	—	5
G. poutassou	1	2
G. callarias	—	1
Hippoglossoides	+	—
Hippoglossus	—	1
Chirolophis	1	—
Gobius	+	—
Triglops	+	1
Clupea harengus	—	1
Lumpenus	+	—
POLYCHAETA	5	5
Aphrodite	+	—
NEMERTEA	+	—
OPHIUROIDEA	1	1
SCYPHOMEDUSAE, *Aurelia*	+	—

TABLE VI

FOOD OF COD ON BORDO AND SVINO GROUNDS (XX23d)

Years	1949–1959	
Months	I, IV, V, VII–XI	
Depth range in metres	84–146	
Length range in cm	21–50	51–90
No. stomachs examined	248	115
No. empty	27	15
No. with recognisable food	185	100
Percentage feeding on:—		
CRUSTACEA	84	66
Decapoda spp.	+	—
Eupaguridae	10	14
Portunus	5	11
Hyas	10	17
Atelecyclus	—	2
Galathea	30	15
Munida	2	—
Crangon	13	7
Pandalus	34	27
Hippolyte	2	—
Isopoda	1	2
Balanus	+	—
MOLLUSCA	24	31
Gasteropoda	22	28
Buccinum	14	13
Neptunea	—	1
Lamellibranchiata	2	3
Modiolus	+	—
Cephalopoda	—	2
POLYCHAETA	6	5
Aphrodite	1	2
Nephthys	+	—
Serpulid	+	—
PISCES	37	67
Ammodytes spp.	4	16
Gadus spp.	2	4
G. aeglefinus	3	24
G. merlangus	+	1
G. esmarkii	+	6
G. poutassou	+	—
Flatfish	—	1
Chirolophis	3	—
Sebastes	+	—
Agonus	1	2
Gobius	+	—
Pholis	+	—
Triglops	2	2
Raia	—	1
Myxine	—	1
ECHINODERMATA	3	2
Asteroidea	—	1
Ophiuroidea	2	1
Holothuroidea	+	—
NEMERTEA	1	4
HYDROIDEA	1	—

Eastern Sando Grounds (Table VII)

Cod of all sizes up to a maximum length of 91 cm were well sampled on these grounds over the entire period of the investigations. The food of the smaller size-group consisted chiefly of decapod crustaceans with *Pandalus* and *Galathea* the outstanding items. In sharp contrast the food of the larger fish consisted predominantly of fish, with sand eels appearing in 67% of the stomachs. Also in contrast to the areas considered so far, the gadoids occurred in less than 10% of the stomachs of the larger fish. Molluscs were identified rather less frequently than on the neighbouring grounds to the north but ophiuroids were recognised somewhat more frequently than hitherto.

Munken Rock Area (Table VIII)

On these grounds the larger cod were more numerous than the smaller fish. Unlike the other Faroese grounds the food of both size-groups of cod consisted equally of decapod crustaceans and fish. Molluscs were again fairly well represented but were exceeded by ophiuroids, which were identified in 13% of the stomachs in both size-groups. This represents the heaviest predation by cod on this type experienced on any Faroese or Scottish grounds with the possible exception of one locality on the west coast of Scotland. Of the decapod crustaceans, *Munida* was identified more frequently in the stomachs of large and small fish than any other type, although *Hyas*, *Galathea* and *Pandalus* were also well represented in the stomachs. It is also noteworthy that *Lithodes maia* was eaten by 9% of the larger cod—the heaviest predation on this deep-water crab recorded anywhere in Scottish and Faroese waters. Of the fish types sand eels were the outstanding item of food for all sizes of cod while gadoids were eaten mainly by the bigger fish.

Myggenaes and Myling Head Grounds (Table IX)

The stock of cod on these grounds would seem to consist chiefly of young fish. The food of the smaller size-group consisted chiefly of decapod crustaceans while the larger fish preyed more heavily on fish. *Pandalus* was the outstanding item in the diet of the 21-50 cm cod but *Eupagurus*, *Hyas* and *Galathea* were also prominent. *Eupagurus* and *Hyas* were also eaten commonly by the larger cod. Of the fish eaten, sand eels were outstanding in the food of both size-groups, gadoids apparently being of relatively little importance on these grounds.

Molluscs, mainly in the form of gasteropods (possibly *Buccinum*) were eaten more frequently than on most other grounds and ophiuroids were taken fairly commonly by the larger cod.

Outer Myggenaes Grounds (Table X)

On these grounds fish were found to be the prominent food of cod of all sizes. This would seem to be owing to the prevalence in the area of sand eels, which were eaten by more than half of the cod in both size-groups. Gadoids, mainly haddock, were eaten by about 20% of the larger fish. At least 9 types of decapod crustaceans were identified in the stomachs, although none was present in outstanding numbers.

West Bay (Table XI)

In this area the larger size-group of cod was sampled rather more frequently than the smaller fish. The chief items in the diet of both size-groups were *Pandalus*, *Hyas*, sand eels, gasteropods and lamellibranchs.

TABLE VII

FOOD OF COD ON EASTERN SANDO GROUNDS (XX22bd)

Years	1949–1962	
Months	III, V–VII, IX, X, XII	
Depth range in metres	65–129	
Length range in cm	21–50	51–91
No. stomachs examined	307	280
No. empty	36	16
No. with recognisable food	271	264
Percentage feeding on:—		
CRUSTACEA	74	19
Decapoda ? spp.	10	+
Eupaguridae	3	2
Portunus	6	1
Hyas	7	6
Atelecyclus	—	1
Lithodes	+	+
Inachus	—	+
Galathea	21	3
Munida	2	+
Crangon	2	1
Pandalus	27	7
Hippolyte	+	—
Scalpellum	+	—
Isopoda	1	—
Euphausiacea	1	—
MOLLUSCA	7	10
Gasteropoda	4	5
Buccinum	3	2
Lamellibranchiata	1	2
Cardium	1	+
HYDROIDEA	1	—
PISCES	49	89
Ammodytes spp.	12	67
Gadus spp.	4	2
G. aeglefinus	1	2
G. esmarkii	3	4
G. poutassou	—	1
G. callarias	+	+
G. merlangus	—	+
Flatfish	—	1
Microstomus	—	2
Glyptocephalus	—	+
Chirolophis	6	2
Lumpenus	1	+
Argentina	+	—
POLYCHAETA	3	2
Aphrodite	+	2
Nephthys	+	—
Stylarioides	+	—
Maldanid	+	—
ECHINODERMATA	3	4
Ophiuroidea	3	4
Holothuroidea	—	+

TABLE VIII

FOOD OF COD IN AREA OF MUNKEN ROCK (XX21acd, XX20b)

Years	1949–1962	
Months	V–VII, IX, X	
Depth range in metres	104–165	
Length range in cm	23–50	51–100
No. stomachs examined	121	235
No. empty	33	58
No. with recognisable food	88	177
Percentage feeding on:—		
CRUSTACEA	51	60
Eupaguridae	3	2
Hyas	9	9
Atelecyclus	—	1
Lithodes	—	9
Galathea	9	4
Munida	15	22
Crangon	1	—
Pandalus	7	8
Spirontocaris	1	—
Isopoda	—	1
MOLLUSCA	9	12
Lamellibranchiata	1	3
Gasteropoda	5	4
Cephalopoda	—	2
Loligo	—	1
Octopod	—	1
PISCES	59	56
Ammodytes spp.	13	12
Gadus spp.	2	3
G. aeglefinus	—	3
G. esmarkii	2	5
G. poutassou	—	1
Microstomus kitt	—	1
Anarhichas lupus	—	1
Triglops	—	1
Chirolophis	—	1
POLYCHAETA	3	3
Nephthys	—	1
NEMERTEA	1	1
OPHIUROIDEA	13	13
Ophiopholis	—	2

TABLE IX

FOOD OF COD ON MYGGENAES AND MYLING HEAD GROUNDS (WW23abc, WW24d)

Years	1952–1962	
Months	II, IV–VII, IX, X	
Depth range in metres	91–165	
Length range in cm	21–50	51–98
No. stomachs examined	616	271
No. empty	84	32
No. with recognisable food	512	239
Percentage feeding on:—		
CRUSTACEA	67	49
Decapoda ? spp.	4	—
Eupaguridae	16	18
Portunus	4	3
Hyas	14	13
Atelecyclus	1	—
Lithodes	+	1
Galathea	11	5
Munida	1	2
Crangon	1	4
Pandalus	19	4
Hippolyte	+	—
Isopoda	+	—
Balanus	+	1
MOLLUSCA	19	27
Gasteropoda	10	18
Buccinum	6	9
Lamellibranchiata	3	2
Pecten	+	—
Chlamys	+	—
Mytilus	+	—
Modiolus	+	+
Cephalopoda	+	1
Eledone	—	1
PISCES	34	63
Ammodytes spp.	22	42
Gadus spp.	1	3
G. aeglefinus	—	3
G. esmarkii	+	—
G. callarias	—	+
Flatfish	+	+
Hippoglossoides	+	—
Chirolophis	1	1
Triglops	+	+
Liparis	+	+
POLYCHAETA	4	2
Nephthys	+	—
Nereis	—	+
Eunicid	+	—
NEMERTEA	—	+
OPHIUROIDEA	5	14
Amphiura	—	+
ANTHOZOA	1	1
HYDROIDEA	+	—

TABLE X

FOOD OF COD ON OUTER MYGGENAES GROUNDS (VV23d, VV22b)

Years	1952–1960				
Months	IV, V, VII, X				
Depth range in metres	108–150				
Length range in cm	24–50	51–99			
No. stomachs examined	149	135			
No. empty	14	19			
No. with recognisable food	135	116			
Percentage feeding on:—					
CRUSTACEA	36	25	PISCES	70	85
Eupaguridae	4	6	*Ammodytes* spp.	59	51
Portunus	3	1	*Gadus* spp.	3	3
Hyas	7	3	*G. aeglefinus*	—	15
Atelecyclus	1	—	*G. esmarkii*	6	3
Lithodes	—	1	*G. poutassou*	—	1
Galathea	—	1	*G. merlangus*	1	—
Munida	5	2	Flatfish	1	—
Crangon	2	3	POLYCHAETA	1	1
Pandalus	6	7	ECHINODERMATA	4	3
Isopoda	1	—	Ophiuroidea	4	2
MOLLUSCA	7	12	*Ophiopholis*	—	1
Gasteropoda	1	2	Holothuroidea	—	1
Lamellibranchiata	1	5			
Cephalopoda	1	2			

TABLE XI

FOOD OF COD IN WEST BAY (WW22abd)

Years	1949–1960				
Months	IV–VII, IX, X				
Depth range in metres	84–156				
Length range in cm	24–50	51–99			
No. stomachs examined	170	204			
No. empty	44	42			
No. with recognisable food	126	162			
Percentage feeding on:—					
CRUSTACEA	59	32	PISCES	46	64
Decapoda ? spp.	3	2	*Ammodytes* spp.	21	28
Eupaguridae	2	5	*Gadus* spp.	2	6
Portunus	1	2	*G. aeglefinus*	1	6
Hyas	10	9	*G. esmarkii*	1	1
Galathea	9	2	*G. poutassou*	2	1
Munida	1	—	Flatfish ? sp.	—	1
Crangon	2	2	*Hippoglossoides*	—	1
Pandalus	28	13	*Gobius*	1	—
Balanus	1	—	MOLLUSCA	16	31
POLYCHAETA	1	1	Gasteropoda	7	6
Aphrodite	—	1	Lamellibranchiata	6	22
OPHIUROIDEA	3	1	*Chlamys*	2	1
Ophiura	1	—	*Anomia*	1	—
Amphiura	1	—	Cephalopoda	—	2
			Loligo	—	1

TABLE XII

FOOD OF COD SOUTH-WEST OF SYDERO (WW21abd)

Years	1959–1962	
Months	V, VII, X	
Depth range in metres	157–256	
Length range in cm	26–50	51–93
No. stomachs examined	10	199
No. empty	3	37
No. with recognisable food	7	162
Percentage feeding on:—		
CRUSTACEA	14	26
Eupaguridae	14	4
Portunus	—	1
Hyas	—	4
Atelecyclus	—	2
Munida	—	6
Crangon	—	6
Pandalus	—	2
Euphausiacea	—	1
MOLLUSCA	29	9
Gasteropoda	29	4
Cephalopoda	—	1
Eledone	—	1
PISCES	86	90
Ammodytes spp.	29	59
Gadus spp.	—	4
G. aeglefinus	—	2
G. poutassou	—	3
G. merlangus	—	1
Hippoglossoides	—	1
Raia	—	1
POLYCHAETA	—	1
Aphrodite	—	1
OPHIUROIDEA	—	1
ANTHOZOA	—	1

TABLE XIII

FOOD OF COD ON FAROE BANK (VV21bcd, VV20b, UU20b)

Years	1949–1962	
Months	V–X, XII	
Depth range in metres	99–165	
Length range in cm	21–50	51–111
No. stomachs examined	74	152
No. empty	1	27
No. with recognisable food	73	125
Percentage feeding on:—		
CRUSTACEA	41	14
Decapoda ? spp.	10	—
Eupaguridae	5	5
Atelecyclus	—	1
Lithodes	—	2
Galathea	7	—
Munida	4	—
Crangon	3	1
Pandalus	7	1
PISCES	77	91
Ammodytes spp.	70	70
Gadus spp.	—	13
G. aeglefinus	—	8
G. esmarkii	—	1
Limanda	—	1
MOLLUSCA	3	2

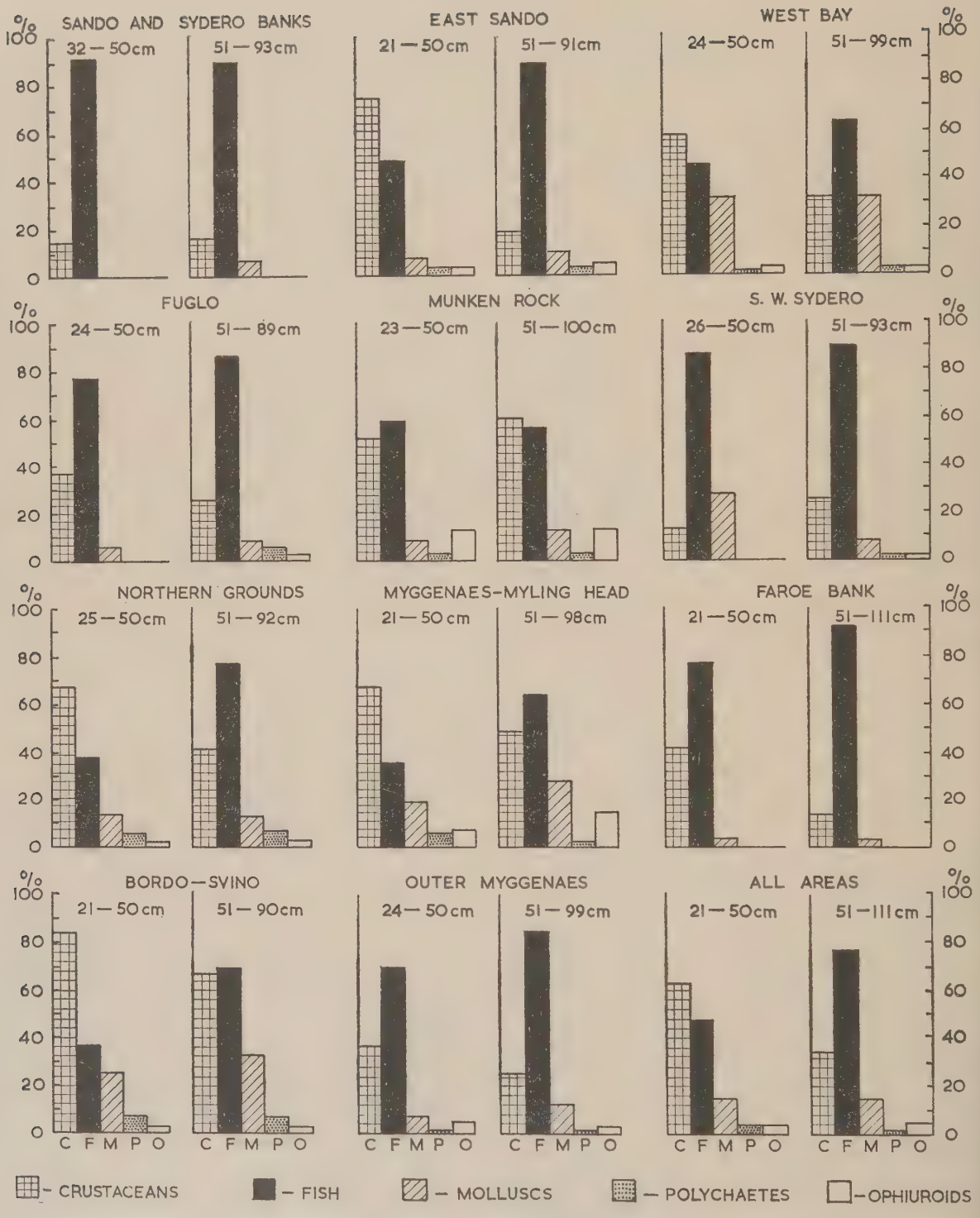

Figure 2. Frequency of occurrence of principal food types in cod stomachs.

OUTH-WEST OF SYDERO (TABLE XII)

In this area the fishing grounds are in deeper water than elsewhere; consequently most of the cod sampled ere over 50 cm long. The few small fish examined were feeding mainly on eupagurids, gasteropods and sand els. The food of the larger fish consisted predominantly of fish with sand eels occurring in 59% of the stomachs.

AROE BANK (TABLE XIII)

Cod of over 50 cm were again more numerous than the smaller fish on these grounds, where fish proved be the predominant food of both size-groups. Sand eels were the outstanding single item occurring in 70% the stomachs of both groups. Gadoids were eaten much less frequently.

CONCLUSIONS

This investigation of the food of cod at Faroe, outside the former territorial limit (3 miles), has revealed number of recurrent features in both time and place. Decapod crustaceans and fish clearly provide the bulk the food of cod of 21 cm and over in each locality. This is demonstrated by the percentages in Tables III XIII and perhaps even more clearly by combining the records from all Faroese grounds—see Table XIV d Figure 2. These show that in the 21-50 cm size-group 62% of the cod were feeding on decapod crustaceans d 47% on fish. Of the cod of 51 cm and over, 34% were feeding on decapods and 77% on fish. This stresses

TABLE XIV

PERCENTAGES OF COD FEEDING ON CHIEF FOOD TYPES ON SCOTTISH AND FAROESE GROUNDS

	21–50 cm		51 cm and over	
	Scotland	Faroe	Scotland	Faroe
Crustacea	62·0	62·5	50·0	34·0
Pisces	54·0	47·2	66·0	76·8
Mollusca	2·7	13·8	4·4	14·9
Polychaeta	2·5	3·1	5·0	2·2
Ophiuroidea	0·5	3·4	1·7	4·4

extent of the change-over from a crustacean to a fish diet as the cod grow in size. Although this holds for st localities anomalies occur on some grounds (see Fig. 2) dependent on the nature of the sea bottom and composition of the resident fish and invertebrate communities.

Although molluscs were eaten by appreciable numbers of cod in both size-groups, they were of much less portance than either of the two chief food types. This phylum was represented mainly by gasteropods and one occasion by lamellibranchs. Polychaetes and ophiuroids were of relatively minor importance over the ire area although the latter were eaten fairly frequently in two localities—the Munken Rock and the Myg-aes-Myling Head areas. Nemerteans and a variety of coelenterate types were eaten on rare occasions but se must be regarded as of little importance.

Of the individual crustaceans identified in the food *Pandalus* was outstanding in most localities and thu must be regarded as the chief decapod type (Fig. 3), while *Eupagurus*, *Hyas*, *Galathea* and *Munida* were als well represented in one or more localities.

Of the fish food-types, two genera, *Ammodytes* and *Gadus*, provided most of the food in each locality an of these *Ammodytes* clearly formed the principal food of cod on most Faroese grounds. Figure 4 shows th percentages of cod of all sizes preying on sand eels in the different localities. Haddock were identified mor frequently in the food than any other gadoid; the incidence of gadoids in the stomachs is shown in Figure 5.

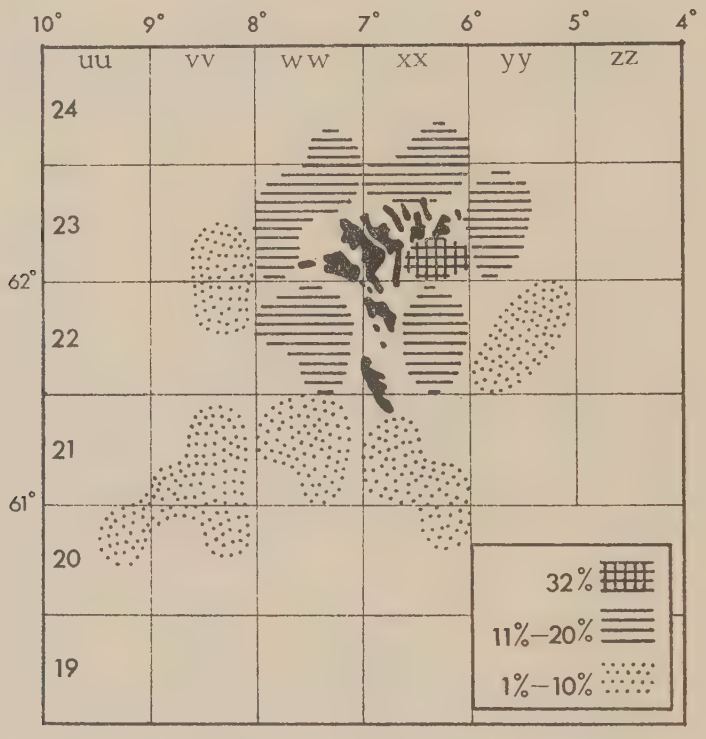

Figure 3. Percentages of cod (21 cm and over) feeding on *Pandalus*.

COMPARISON OF FOOD AT FAROE WITH THAT IN SCOTTISH WATERS

These observations, when compared with the results of similar work in Scottish waters, demonstrate th overall similarity of the food of cod in both areas, despite the absence of certain southern genera an species from the stomach contents at Faroe owing to the geographical difference in the two regions. In ea region the list of organisms in the food is extensive, although, as already noted in the Scottish area, the bulk the food is derived from a relatively small number of genera or sub-types. These are predominantly decap crustaceans and fish, and in each region the change-over from crustaceans to fish is evident as the cod increas in size.

In each region cod of all sizes also fed on three subsidiary types, molluscs, polychaetes and ophiuroid and from time to time organisms from other invertebrate groups, for example nemerteans, gephyreans an coelenterates, have also been identified in the stomachs.

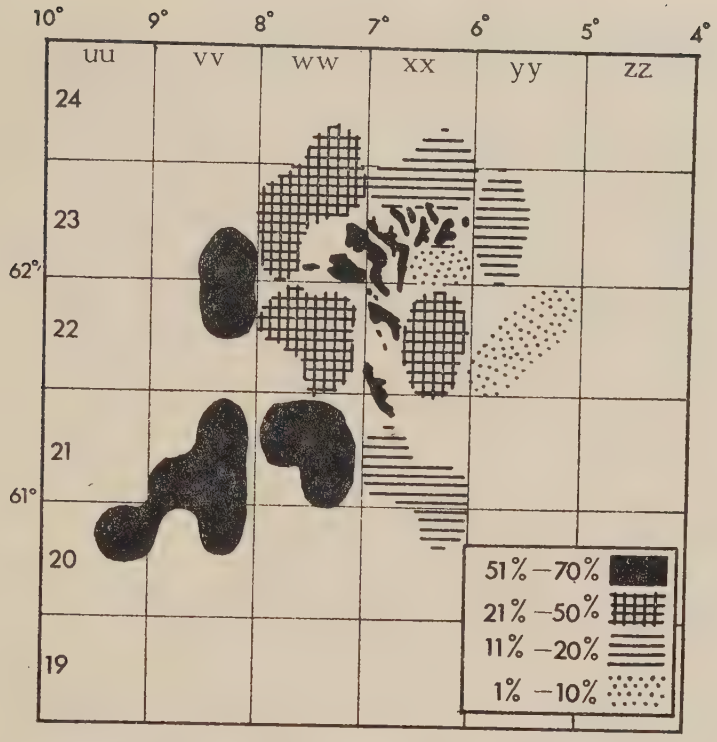

Figure 4. Percentages of cod (21 cm and over) feeding on sand eels, *Ammodytes*.

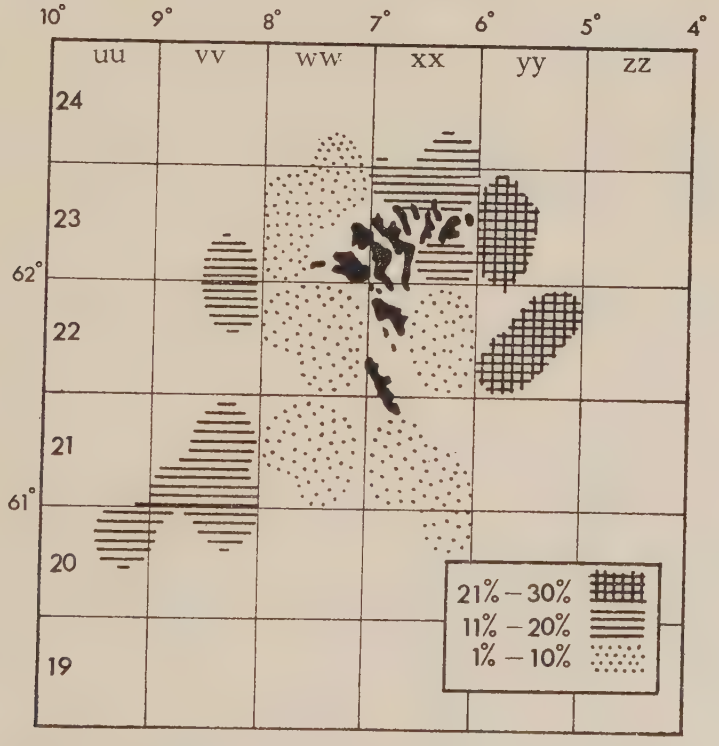

Figure 5. Percentages of cod (21 cm and over) feeding on gadoids.

Despite the general similarity of the food on Scottish and Faroese grounds some well defined differences are evident. This may be observed in the first place in the overall percentages of cod preying on the chief food types (Table XIV). In both regions the smaller cod prey equally heavily on decapod crustaceans but this size-group feeds rather more heavily on fish in Scottish waters than at Faroe. The larger cod feed more heavily on crustaceans in Scottish waters than at Faroe and evidently take more fish at Faroe than in the Scottish area.

Table XIV also reveals a greater predation by all sizes of cod on molluscs at Faroe than in Scottish waters. This appears to have been achieved by a greater concentration by the cod on *Buccinum*. Polychaetes on the other hand were clearly taken less frequently at Faroe. In the North Sea the relatively high predation on polychaetes was considered to be mainly owing to the cod's apparent preference for *Aphrodite aculeata*, so that it seems probable that the small proportion of cod feeding on polychaetes at Faroe may be explained by *Aphrodite's* relative scarcity there. As also shown in Table XIV ophiuroids were eaten more frequently by cod of all sizes at Faroe than in Scottish waters, although intensive predation would appear to be local in both regions.

In comparing the food of cod in the two regions, however, some of the most obvious differences lie in the proportions feeding on certain species or genera. The most striking difference is perhaps the complete absence of *Nephrops norvegicus* from the stomachs at Faroe. This species was found to be the outstanding food item in a number of Scottish localities, and since it is also fished commercially at Faroe the failure to find a single specimen in more than 4,000 stomachs is rather surprising. The explanation would seem to be that at Faroe *Nephrops* is confined to territorial waters and perhaps even to the fjords where no cod sampling was done by Scottish research vessels. *Eupagurus*, *Hyas*, *Crangon* and *Portunus* were identified rather less frequently at Faroe than in the Scottish area. As already indicated *Pandalus* proved to be the outstanding single decapod type in the food at Faroe.

It has also been noted that various species of sand eels and gadoids provided the bulk of the cod's fish prey at Faroe. Sand eels were eaten by cod of all sizes in every locality (Fig. 4) and thus must be regarded as the overall predominant item in the cod's food, as they are off the north of Scotland and in certain other Scottish localities (Rae, 1967).

Because of the importance of sand eels it seems worthwhile considering their seasonal prevalence at Faroe. Accordingly the percentages of cod of all sizes preying on sand eels on eastern and western Faroese grounds have been arranged on a monthly basis in Table XV. This stresses the availability of sand eels in every month of the year and on the whole would seem to suggest that predation by cod is heaviest in July. The high proportion of the cod feeding on this food type in March and April is also of interest but the most surprising feature of the table is the small numbers feeding on sand eels in June. It is difficult to suggest an explanation for this phenomenon, which may, however, be linked with the annual life cycles of the predator and the prey.

TABLE XV

MONTHLY PERCENTAGES OF COD PREYING ON SAND EELS (*Ammodytes*) ON EASTERN AND WESTERN FAROESE GROUNDS

Months	East				West			
	21–50 cm		51–100 cm		21–50 cm		51–100 cm	
	No. Exam.	% Feeding on *Ammodytes*	No. Exam.	% Feeding on *Ammodytes*	No. Exam.	% Feeding on *Ammodytes*	No. Exam.	% Feeding on *Ammodytes*
I & II	111	8	73	27	6	17	8	37
III & IV	6	33	16	75	20	60	21	81
V	8	50	21	29	52	6	61	41
VI	126	1	43	0	246	17	73	27
VII	92	52	275	77	190	86	282	84
VIII	—	—	—	—	—	—	—	—
IX	235	6	147	6	190	23	121	40
X	321	7	284	9	99	4	138	14
XI & XII	52	6	54	15	63	3	87	20

Among the gadoids (Fig. 5), the haddock appeared more often in the cod stomachs than any other species and seem to be of greater importance as cod food than in Scottish waters. *Gadus esmarkii* came next in order of importance and was followed by *G. poutassou*, cod and whiting. The inferior position of the last named species is in sharp contrast to its importance as the commonest gadoid in the food of North Sea cod, but this no doubt merely reflects the relative numbers of the various gadoids in the two regions. Another very marked difference in the food in the two regions is the remarkable scarcity of herring in the stomachs of the Faroese cod. This is in sharp contrast to the situation in Scottish waters where herring, both as adults (on offshore grounds during the summer) and as juveniles (in the firths or river estuaries during the winter), represent an important seasonal food for cod. The absence of mackerel and sprats from the food of Faroese cod is also remarkable although this may be explained by the more southerly distribution of these species. Records from both Scottish and Faroese grounds are in agreement in showing little evidence of predation by cod on the young of their own species, such as has been experienced in some Arctic waters.

SUMMARY

The stomach contents of more than 4,200 cod of 21 cm and over were examined on Faroese grounds from 949 to 1962. On the evidence of the proportions of empty stomachs and of the fullness of the stomachs, the nnual feeding cycle of cod at Faroe is shown to resemble that of cod in the North Sea and on west of Scotland rounds. In each region the feeding intensity is heaviest during the summer and is both preceded and followed y periods of minimal feeding compared with the other times of the year. The various phases of the feeding ycle are each about one month later at Faroe than in the Scottish area.

The food of cod at Faroe resembles that of the North Sea and west of Scotland grounds and consists rimarily of decapod crustaceans and fish supplemented by smaller quantities of molluscs, polychaetes and phiuroids and negligible quantities of a number of other types. As the cod grow in size there is a partial change-ver from decapods to fish.

Pandalus is the commonest decapod eaten by cod on most Faroese grounds but sand eels are eaten more requently than any other organism, particularly on Faroe Bank and other grounds on the west side of the slands. Predation on sand eels is evident throughout the year but is heaviest in July. Gadoids also form an nportant food of cod, haddock being the commonest species eaten.

A comparison of the food at Faroe with that of Scottish waters shows some marked differences despite the eneral similarity in the two regions. The most obvious of these are the complete absence of *Nephrops norvegicus* nd the extreme scarcity of herring and whiting in the stomachs at Faroe.

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Appendix

SPECIES AND GENERA IDENTIFIED IN THE STOMACH CONTENTS OF COD AT FAROE, 1949–1962, WITH PLACES OF OCCURRENCE

CRUSTACEA

DECAPODA – REPTANTIA

Eupagurus sp: YY22, 23; XX20, 21, 22, 23, 24; WW21, 22, 23, 24; VV22, 23; Faroe Bank.
E. bernhardus (L.): YY23; XX23; WW23; VV22.
E. pubescens (Kröyer): WW22.
Portunus sp.: YY23; XX22, 23, 24; WW21, 22, 23, 24; VV23.
P. holsatus Fabricius: XX23.
Hyas sp.: YY22, 23; XX20, 21, 22, 23, 24; WW21, 22, 23, 24; VV22, 23.
H. coarctatus Leach: YY23; XX20, 21, 22, 23; WW22, 23.
Atelecyclus sp.: XX20, 22, 23; WW21, 23, 24; VV23; Faroe Bank.
Inachus sp.: XX22.
Lithodes maia (L.): YY22; XX20, 21, 22, 24; WW23; VV23; Faroe Bank.
Galathea sp.: YY22, 23; XX20, 21, 22, 23, 24; WW22, 23, 24; VV22; Faroe Bank.
Munida sp.: YY22, 23; XX20, 21, 22, 23; WW21, 22, 23, 24; VV23; Faroe Bank.
M. bamffica Pennant = ? *M sarsi* (see Stephensen, 1939): XX23.

DECAPODA – NATANTIA.

Crangon sp.: YY22, 23; XX20, 22, 23, 24; WW21, 22, 23, 24; VV22, 23.
C. allmani Kinahan: YY23; VV22.
Pandalus sp.: YY22, 23; XX20, 21, 22, 23, 24; WW21, 22, 23, 24; VV22, 23; Faroe Bank.
P. montagui Leach: YY23; XX21, 23; WW22.
Hippolyte sp.: XX22, 23; WW23.
Spirontocaris pusiola (Kröyer): XX21.

ISOPODA

Arcturus baffini Sabine: XX21, 24; VV23.
Astacilla sp.: XX22.
A. longicornis (Sowerby): XX22.

CIRRIPEDIA

Balanus sp.: XX23; WW22, 23, 24.
Scalpellum scalpellum (L.) = *S. vulgare:* XX22.

PISCES

Ammodytes sp.: YY22, 23; XX20, 21, 22, 23, 24; WW21, 22, 23, 24; VV22, 23; Faroe Bank.
Gadus sp.: YY22, 23; XX20, 21, 22, 23, 24; WW21, 22, 23, 24; VV22, 23; Faroe Bank.
Gadus sp.: YY22, 23; XX20, 21, 22, 23, 24; WW21, 22, 23, 24; VV22, 23; Faroe Bank.
G. aeglefinus (L.) = *Melanogrammus aeglefinus:* YY22, 23; XX20, 21, 22, 23; WW21, 22, 23, 24; VV22, 23; Faroe Bank.
G. merlangus (L.) = *Merlangius merlangus:* XX22, 23; WW21; VV23.
G. esmarkii Nilsson = *Trisopterus esmarkii:* YY22, 23; XX20, 21, 22, 23; WW22; VV22, 23; Faroe Bank.
G. callarias (L.) *G. morhua:* XX22, 23; WW23.
G. poutassou (Risso) = *Micromesistius poutassou:* YY22, 23; XX21, 22, 23, 24; WW21, 22; VV23.

Clupea harengus (L.): YY23; YY23.
Limanda limanda (L.): Faroe Bank.
Hippoglossoides platessoides (Fabricius): YY22; XX23; WW21, 22, 23.
Microstomus kitt (Walbaum): XX21, 22.
Glyptocephalus cynoglossus (L.): XX22.
Hippoglossus hippoglossus (L.): XX23.
Anarhichas lupus (L.): XX20.
Agonus cataphractus (L.): XX23.
Pholis gunnellus (L.): XX23.
Chirolophis galerita (L.): XX21, 22, 23; WW23, 24.
Triglops murrayi Günther: XX20, 23; WW23.
Lumpenus lampetraeformis (Walbaum): XX22, 23.
Gobius sp.: YY23; XX23; WW22.
Argentina sp.: XX22.
Liparis sp.: WW23.
Sebastes sp.: YY22, 23; XX23.
Raia sp.: XX23; WW21.
Myxine glutinosa (L.): XX23.

MOLLUSCA

GASTEROPODA

Buccinum sp.: XX22, 23, 24; WW23, 24.
Neptunea antiqua (L.): XX23.
Emarginula crassa Sowerby: XX23.

LAMELLIBRANCHIATA

Anomia sp.: WW22.
Cardium echinatum (L.): XX22.
Modiolus sp.: XX21, 23; WW23.
Mytilus sp.: XX23; WW23.
Pecten sp.: XX23; WW24.
Chlamys sp.: XX23; WW22, 23.
*Chlamys operc*ularis (L.): WW22.

CEPHALOPODA

Eledone cirrhosa Lamarck: XX22, 23; WW21, 23.
Loligo sp.: XX20; WW22.

POLYCHAETA

Aphrodite aculeata (L.): YY23; XX22, 23; WW21, 22.
Nephthys sp.: XX21, 22, 23; WW23.
Stylarioides sp.: XX22.
Serpulid: XX23.
Maldanid: XX22.
Eunicid: WW23.
Nereis sp.: WW23.

ECHINODERMATA

ASTEROIDEA

Asterias rubens: XX23.

OPHIUROIDEA

Ophiopholis aculeata (L.): XX20, 21, 22; VV22.
Ophiura sp.: XX22; WW22.
Amphiura sp.: XX24; WW22, 24.

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